

large number occurred on the 1st and 2d, and from the 11th to the close of the month they were general. The larger number occurred in the mountainous country and in the basin and plateau region to the eastward of the Cascade Range. More than 40 stations in the State of Oregon alone reported one or more thunderstorms.

Killing frosts occurred at over a dozen stations in Oregon, and light to heavy frosts at a good many more points in Washington and Idaho. Damage was not general, however, being confined to limited areas.

Sunshine was deficient in Washington, particularly west of the Cascade Mountains. It was somewhat below normal in northwestern Oregon, but elsewhere in the district there was about the usual amount.

The average wind direction was from the west, and the highest velocity reported was 56 miles an hour from the southeast at North Head, Wash., on the 14th.

#### WATER RESOURCES IN OREGON AND THEIR DEVELOPMENT.

By JOHN T. WHISTLER, Member American Society of Civil Engineers.

A prominent man in public affairs said recently with reference to certain of our country's natural resources: "There is but one protection—an awakened public opinion. That is why I give you the facts."

It is certainly very true that if we are to make the most of our natural resources there must be a wide general knowledge of what they are and the conditions surrounding them.

More than six years ago I had the privilege of conveying to the joint committee on irrigation of the Oregon State Legislature, then in session, the offer of the Director of the United States Geological Survey to allot, from the Federal appropriation for stream-gaging work, an amount equal to whatever the State legislature would appropriate for the same purpose, not exceeding \$25,000 per annum; that is, if the State would appropriate \$25,000 for stream-gaging work in Oregon, the United States Geological Survey would allot from the Federal appropriation a similar amount, making \$50,000 per annum for stream-gaging work.

Other States, more keenly alive to the value of such work, promptly accepted similar offers, and it is not now so easy to get the full amount originally offered.

What the State legislature actually did, was to appropriate only 10 per cent of the full amount offered, or \$2,500. The United States Geological Survey, true to its offer, allotted an equal amount each year. This year, as a result of the continued agitation, the State legislature appropriated a total of \$25,000 for hydrographic and topographic work, about \$10,000 of which goes to stream-gaging work. The United States Geological Survey has allotted a similar amount.

#### QUANTITY OF WATER AS AFFECTING IRRIGATION, WATER-POWER DEVELOPMENT, AND NAVIGATION.

Taking up the features of water resources having more direct reference to quantity. I wish to show the short-sightedness displayed in developing a knowledge of what the resources of this character are in the State of Oregon.

About the first things an engineer must consider in either an irrigation or a water-power project are, What are the mean daily discharges, what is the minimum discharge and its duration, and what is the maximum rate of discharge that will have to be taken care of. The latter will not be determined by 10 or 25 years' records, or even a 100-year record, as witnessed in the recent flood of the

river Seine in France. Such reports will be of value, though, in aiding to form a judgment of what it may be. The mean daily discharges, however, and the probable yearly variation from them in the future, will be fairly well known, and this can not be even reasonably determined in any other way.

It makes no difference how valuable such information would be to the State of Oregon, directly or indirectly, to-day or to-morrow, concerning some stream of which such gagings and records have not been made and kept, no amount of money can obtain them now. It costs very little money as compared to its value, but it requires years of time.

I can call to mind irrigation projects which would involve the expenditure of many millions in construction in Oregon, but which can not be financed at the present time because of the very meager knowledge of the available water supply. The same can be said of power projects. If the people generally could only realize the value of this knowledge I feel the demand for a still larger appropriation by the legislature would be such as to make it one of the first acts of the next session.

The value of this knowledge of stream flow is not alone in connection with the development of new projects, but it is also in the better and more equitable distribution of existing water rights. Last year my attention was called to a news item from Roswell, N. Mex., in which it was stated that since the completion of the Hondo project by the Reclamation Service some two years prior, the reservoir had not received a drop of run-off. I understand that this was true, and that practically the same conditions have continued to the present time.

The Sweetwater Dam in southern California was completed to a height of 95 feet in 1895. It created a storage reservoir of 22,500 acre-feet capacity. During the eight years prior to this the run-off at the dam had averaged nearly this amount, though over two-fifths of it ran off in one year. The total run-off for the next nine years was less than half enough to fill the reservoir once, and probably barely supplied evaporation. During four of these years there was absolutely no run-off at the dam, and three of these years were successive.

After 10 years, during which the total run-off was not sufficient to fill the reservoir once, the supply has again been abundant, and the dam this year has again been increased by sufficient to approximately double the capacity of the reservoir. This is practically the fourth time the dam has been increased, yet there is little doubt that if a better knowledge had been available of the stream's characteristics the dam would never have been commenced.

The feeling is yet prevalent with most Oregonians that irrigation in the Willamette Valley would be like "carrying coals to Newcastle," but it is a fact that the average precipitation in this valley during the growing season is less than in many of the arid regions. This is well illustrated in the diagram, Fig. 1, compiled from the records of the United States Weather Bureau and published by the Oregon Conservation Commission, which has undertaken to promote irrigation in the Willamette Valley.

A knowledge of water resources is not complete when we have made analyses of the character of all our waters and have obtained long records of rate of discharge, as we also want to know what can be done to increase the minimum discharge of a stream. This is as true for power development as for irrigation. The minimum flow of a stream usually determines the maximum economic development of a power project, because a power good for only nine months in the year has little demand, and the instal-